SCIENCE

NEW SERIES
VOL. LX, NO. 1549

FRIDAY, SEPTEMBER 5, 1924

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

SCIENCE

VOL. LX SEPTEMBER 5, 1924 No. 1549

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

THE RESEARCH SPIRIT IN MODERN LIFE[1]

FOR four years, living in this delightful community, under the guardianship of this great institution, participating in its benefits, drawing from its rich sources of supply, both material and intellectual, you young men and women have been through a process of development that marks a most important stage in your life career. But to-day we may not look only upon the memories of the past four years, but with januform vision look forward as well and realize that we are at the commencement of a long period of life, for the most part, alas, unprotected by the motherly arms of the university and the cooperative efforts of class, fraternity and sorority mates.

It is indeed the unusual undergraduate who senses the true privilege that he is enjoying by life in this community. The money he contributes is but a small fraction of the cost entailed in providing the educational facilities here to be found. Everywhere about this campus there are evidences of the munificence of the state, the town and those who have passed on and who in grateful memory of what they have received here have attempted in manifold ways to repay their debt.

Laboratories, libraries and indeed fraternity and sorority houses are all evidences of the appreciation of those who have stood exactly as we are standing on this eventful day, many years ago. For four years this campus has seen you all, going hither and thither, each occupied with his or her problem, but each necessarily, perhaps subconsciously, mindful of the community's welfare. While everywhere one finds that freedom of action and freedom of speech have been encouraged, nevertheless no man can assert his rights if those rights are not sane and unobjectionable to the majority of his classmates, for with freedom of speech comes responsibility and weighing of words. So college life has taught us that each, personally, must have the welfare of others at heart.

The underlying spirit which has so coordinated the entire community life and has made for betterment of the moral and physical and intellectual body has been that of trying, experimenting, proving, developing, for progress even in the smallest degree can only be made or attained by experiment, although with a community as large and with the wide diversity of interests as is here found, obviously much of its life rules and principles must have been preformulated.

[1] Commencement address given at the University of Maine on June 9.

Nevertheless a moment's reflection will show that this university is by no means the same university that it was four years ago, when you entered it. Even in this brief span of time there have been most profound changes. I am not speaking solely of the material but chiefly of the intellectual, the habit of thought and the line of reasoning, all of which are produced by an unceasing development of the spirit of unfolding, searching for the new, proving, testing. This spirit we may properly call the spirit of research. The common use of the word "research" which is so often, in my judgment, erroneously confined to the research and study for material development fails to express the broader and cultural significance of the word.

Individual effort, though the basis of all research, must be directed not to selfish but to communal welfare. Prehistoric man could advance but little as a single member of society; he could alone make but feeble headway against the vicissitudes of life, but the clan and the patriarch, with his family gathered about him, moved and worked all in the interests of the group. The needs of early man were few, and it was only slowly (perhaps in time reckoned in thousands if not in tens of thousands of years) that the simplest commodities became available to him. Thus fire, that greatest agency for the development of mankind, came into the hands of primitive man very late and probably as a result of accident. No other single agency made possible such fundamental alterations in primitive man's whole method of living. His first knowledge of it was undoubtedly the aftermath of the thunderbolts, and lightning flashes, with devastating forest fires, which filled him with great terror. Far from being inclined to duplicate these frightful events, he would seek to avoid contact in any way with such an agent, and it is rather difficult to imagine that the cave-dweller realized the development of heat by friction, the sparking of flint and ignition therefrom, or the concentration of the sun's rays by means of a spherical mass of crystal or of ice, so in all probability this great asset came to man as a result of accident.

Controlled fire with its incalculable advantages is probably the best example of man receiving into his hands by accident mastery of one of the greatest forces of nature, and yet we may possibly be doing injustice to some mute, inglorious Franklin, who by some subtle spark of genius and thought may have planned simple tests or efforts to secure this commodity. One could almost wish that one could be assured that such were the case, for it is a fact, at the present date, that additions to our knowledge, proving of material value to the world, are rarely the result of accident but are usually the end-result of a long, painstaking series of carefully developed plans and concentrated efforts upon a pre-conceived and hoped-for end. Undoubtedly when one considers the innumerable inventions of the present day, *some* were the result of accidental findings, but few, if any, great discoveries are based upon accident, for a great invention is one that involves utilization, classification and interrelation of one or more great basic principles upon which all our material progress is founded.

It is this method of attack that is exemplified in its highest form in research. With each new development there accumulates with almost geometric ratio a widening of activity, control of forces, utilization of powers formerly undreamed of. Without doubt our cave man immediately applied his control of fire to the preparation of foods, thus resulting in altering his diet. It made possible his excursions into colder climates and it gave him an agent in combatting the maraudings of wild animals and, indeed, at times his fellowmen.

So with each research problem successfully completed at the present day our field of endeavor immediately widens. Franklin's daring in drawing electricity from the clouds with his kite but a little over a century ago has broadened now into such a diversity of uses of electricity that the mind staggers with its efforts even to classify them. And yet all this has happened within, relatively speaking, a few hundred years. It has been recently asserted that in all probability man in essentially an unaltered physical form will be upon this planet for not far from four or five million years. During this time there is no reason to suppose that there should be a cessation or retardation of progress, so that in a way we are simply at the threshold of human development, and while we find ourselves surrounded by all sorts of comforts and luxuries undreamed of, yet, as surely as we are here to-day, in 200 years we will be considered almost as a primitive people.

The side wheel steamer of 60 years ago is fast disappearing. Who cares or, indeed, *dares* to ride the high wheel bicycle, and Fifth Avenue is without its splendid horse-drawn equipages that dazzled the beholder by their luxury and elegance hardly 20 years ago. These are the effects. The cause is the development of research in transportation agencies, giving us the propeller, the modern bicycle and the automobile. These are all the result of *design* and not accident.

On one of those white marble buildings comprising that magnificent group of research centers at the Harvard Medical School there is a tablet showing that this particular building was the gift of Mrs. Arabella D. Huntington in memory of her husband, Collis P. Huntington, the great railway magnate. Former President Charles W. Eliot, with his inimitable style, wrote for this tablet a few words which

embody so perfectly the spirit of research that they should be on the wall of every educational institution. The inscription reads: "Life is short and the art long, the occasion instant, experiment perilous, decision difficult." In no other way could one in so few words express the entire spirit of research, for this is really an epitome of the research spirit with the dominant note *design* and not accident. Let us read again this tablet. "Life is short." In the progress of science nothing could be shorter than life. When our paleontologists are discussing prehistoric man in the terms of tens of thousands of years and when our prophets are implying that we have still some millions of years to live, each of those organisms known as man has but a brief, transitory sojourn on this earth. What a depth of meaning there is in the expression "The art is long." What is more enduring than the art? And by the art one does not mean simply the esthetic expression of man's sublimest thoughts in the form of prose or painting or chiselled stone or monumental pile, but all that man can by skill, thought and plan contribute to civilization.

Again we read, "The occasion instant, experiment perilous." In these advancements which must inevitably continue with man's prolonged existence there are periodic instants where the occasion for observation, for test or proving may exist for but a very short time. To distinguish between the essential and the nonessential is one of the most difficult features in developing observational powers. The danger of not making the critical experiment at the proper time is indeed perilous, perilous to progress. The perilous nature of experiment rarely involves danger to the life of the individual making it, and yet history affords instances of such occurrences.

But when we think of the heroic tests of Major Walter Reed and his associates, when by submitting to the poisonous, death-dealing sting of that pestilential yellow fever carrier, the mosquito, they sacrificed their bodies on the altar of science, one can truly say that experiment is perilous.

The entire path of the research worker is strewn with difficulties, but, after all, the most difficult things are the best things, the things most appreciated, the accomplishment of which is accompanied by the greatest gratification. Difficulties begin immediately with the assessment of the values of earlier work, as to what is to be saved, what is to have bearing upon the new problem, and what is to be rejected. The experimental conditions, with their technicalities and niceties of adjustment, present further difficulties. The discrimination of the essential from the nonessential in observation next presents difficulties, and above everything else there is the greatest difficulty in interpreting results of experimentation, so that the words "decision difficult" are continually before the research worker.

True research must take into consideration past experience, a careful survey of what has gone before, with a particular view as to the correct path to follow, and *then* the attack upon the problem under investigation. Accident has little, if any, place in a research program. Yet at times there are of course fortuitous discoveries of wonderful importance. The great transcontinental railroads in cutting through a mountain are bent upon securing the most direct route of transportation, but do not the marvellous fossil remains accidentally uncovered in connection with their excavations unfold innumerable pages of past history? On the contrary, Benjamin Franklin's drawing electricity from the air during a thunderstorm with his kite and key was by no means an accident. Here we might well repeat Dr. Eliot's words, "The occasion instant, experiment perilous."

To what extent research enters into modern life can best be seen when one realizes that all our largest industrial organizations have definite sections devoting a large part of the time of a considerable number of workers to research, mainly, it is true, on problems of specific economic interest for the corporation. While of course many processes are retained as "trade secrets," a very large amount of the work is published and thus made available for all mankind. So important an influence upon the success of the corporate existences are these research divisions that a definite budget is assigned to them, and in making up the cost of *your* electric light bill or *your* telephone bill unquestionably a certain fraction is definitely assigned for further research. The reason that our telephone instruments are so superior, that our photographic films are of such a high quality, that our X-ray tubes are capable of such marvelous penetration, is due to the fact that the Eastman Kodak Company, the General Electric Company, the Westinghouse and the Western Electric Companies recognize research as an integral part of their system. The remarkable group of men that the General Electric Company has devoting their entire time to research need only be listed to show the importance of this phase, for where will you find such men as Elihu Thomson, W. R. Whitney, Coolidge, Langmuir, and, I am happy to add, a distinguished graduate of this university, Dr. E. R. Berry. What the physician owes to Coolidge for his work on the X-ray tube can not be adequately expressed Professor Thomson's and Dr. Berry's work upon fused quartz has hardly been opened. The possibilities of applying quartz to medical and optical purposes lie far beyond the original intent of the General Electric Company to secure a better insulator for high tension currents—of itself an achievement of no small distinction.

The telephone and telegraph companies would be tremendously handicapped without men like General J. J. Carty and Professor M. Pupin. The experience of many of these men reads like a novel. Those of you who have read Professor Pupin's marvelous autobiography "From Immigrant to Inventor" can trace out there the development of one of the foremost men of research in America. That Professor Pupin, working as a mathematical physicist at his desk and with pure mathematics, should have developed the theory of the Pupin coil, a theory which with a relatively few experimental proofs subsequently in the laboratory demonstrated its complete truth and made possible this simple, though effective, agent for long distance telephony, is one of the most marvelous tributes to intellectual power and research spirit. That the eminent specialist in the east can give his advice instantly and clearly in a critical case in the west is due to Professor Pupin.

Our universities have long been the fountain heads of the most of American research. Handicapped in many instances by lack of funds, overloaded with instruction and departments undermanned, nevertheless the university professor has struggled for decades and has accomplished even under these most disadvantageous conditions a vast amount of most highly productive research. Nowhere more than in the university is it clearly recognized that it is the duty of educators not simply to draw upon the fund of previously stored knowledge but to make substantial additions thereto. Indeed, a university without a sufficient spirit of research to have a definite plan of contributory activity to progress through research agencies does not deserve the name of university. Every university professor, indeed, every secondary school teacher, should have a modicum of the research spirit.

The interdependence of the university as a research center and the large industrial corporations' research laboratories is very close. Too often the glory and emphasis are laid upon the final outcome of the research. Thus one hears of the perfected motion picture, the X-ray, radio, etc., but hardly a handful of men realize that the motion picture began in the modest laboratory of the physiologist Marey in the outskirts of Paris, studying the physiology of motion, and we too often forget that Wilhelm Roentgen, who made the X-ray pictures possible, was a professor of physics in a German university, as indeed was Hertz, whose investigations form the basis for all radio work.

Obviously the man or woman intellectually well endowed, having received an excellent education, with sufficient means or environment to conduct research unhampered either by anxiety with regard to the cost of living or cost of materials and assistance, has a very great advantage over others who are less fortunate, but the research spirit remains indomitable in the research man. The spirit of research knows no handicaps. We must not forget that Pasteur carried out a long series of most critical experiments when partially paralyzed. In citing a few moments ago the names of some eminent men in connection with the General Electric Company, one name was purposely omitted, for that list contained only living men. But no one can speak of the progress of the General Electric Company without thinking of that strange, misshapen genius, Charles Proteus Steinmetz, whose every word was law and gospel in a General Electric building, a man who was suffering from many physical handicaps and deformities and yet was intellectually gigantic, a man to whom it is said no regular salary was paid. His living needs were small and modest, and the General Electric Company simply gave him "carte blanche" to draw upon them for money as he wanted it. Steinmetz worked for no material gain. He loved his work; he lived for research and he doubtless felt much of the spirit expressed by that great French chemist, Lavoisier, who not long before his tragic end by the guillotine wrote:

> To merit well of humanity and to pay tribute to one's country it is not necessary to take part in brilliant public functions that have to do with the organization and regeneration of empires. The naturalist may also perform patriotic functions in the silence of his laboratory and at his desk; he can hope through his labors to diminish the mass of ills which afflict the human race or to increase its happiness and pleasure; and should he by some new methods which he has opened up prolong the average life of men by years or even by days he can also aspire to the glorious title of benefactor of humanity.

The significance of the research spirit in teaching has been entirely, in my judgment, overlooked. There has been a feeling that research men are members of a closed corporation, that there is a sanctity of the research laboratory, a spirit of the cloistered hall of the ascetic. But this is entirely false. The teacher has the possibilities for not only instilling the spirit of research into the students but likewise of actually accomplishing research. Many of you doubtless are planning to enter teaching, that occupation of which Erasmus once said to Sapidus (a well-known German schoolmaster): "To be a schoolmaster is next to being a king. In the opinion of fools it is a humble task, but in fact it is the noblest of occupations." To-day the teacher is by no means confined to the conventional three R's, reading, writing and arithmetic. The introduction of health studies, of interest in outdoor life, observations with regard to forestry and gardening and a disposition to enter into the "raison d'être"

of things in general has entered pronouncedly into all our college curricula and our school systems.

Indeed no branch of life is devoid of research interest. If I may be pardoned a personal allusion, I have often spoken before medical and scientific societies on the importance of research, and occasionally some one has said "Yes, it is very easy for one whose life is cast in a research environment to speak about the importance of research, but what can the poor country doctor, who has no special apparatus, no large clinic, what can he do to further research?" My answer to that is this. Every country doctor has a stethoscope or at least he certainly has a hand, with which he can count pulse. I have seen an occasion where an entire research of great importance, upon the physiology of children, was absolutely stopped because this simple point was unknown. How long after a meal does the pulse rate of children, which is accelerated by the meal, return to its normal rate? It was necessary to stop one research, begin another and devote several weeks to answering this question first. Any country practitioner could have counted the pulse rate of his children after they had gone to sleep at night and have answered the question in an admirable way.

Of course there are many problems that are of interest and fewer that are of importance. The research spirit perhaps may not invariably distinguish carefully which are important and which are merely of interest, but after all it is not so much the end result as it is the encouragement and the inculcation of the research spirit throughout our entire educational life that will accomplish the greatest ends. Who knows but what before me to-day there may be sitting the future Mayo, the Elihu Thomson, the Marie Curie, the Pupin or the Carrel? With the spirit of research thoroughly imbued in our hearts, no one can dare to predict the practical results of such a spirit in the next two or three decades with the youth of to-day. Every school teacher in the most remote school has the ever-present problem of child psychology. Too little is known about it. Human behavior is almost an uncharted field. There is today in the air a plan for a very large research, involving the study of human behavior. Certainly the district school teacher, with a group of children ranging from 4 to 40 years, has problems of the most complex nature continually confronting her. No one needs more knowledge with regard to the psychology of youth, for every child, no matter how stubborn, no matter how seemingly indifferent, has some point of contact, which, if once found, may open up an entire new life vista. The finding of this contact, the opening up and the development of that child has potentialities of the greatest importance. To-day simple rules for psychological tests are available to every school teacher. They have of course greater or less value and one must sound a note of warning, for without intelligent interpretation of the results one can reach the conclusion which was found by one ardent investigator—that all college professors should really be classed as morons. The fact that in yonder building there is a mouse colony contributing to our knowledge of genetics and cancer is of vastly more importance to this institution as a whole, from the educational standpoint and from the spirit that it exemplifies than from the actual contributions to our fund of knowledge, great though they are.

Thus far it has been natural, perhaps too natural, for me to lay emphasis upon research from the standpoint of developing our material knowledge, and yet I feel that I can not overemphasize the *spirit* underlying research as after all being the main thing. What stimulates men and women to research? Many of our industrial organizations have adequately remunerated their scientific research men with substantial rewards that no one would think of denying them. And yet, after all, there are extremely few of the men who have devoted their lives to scientific research who have benefited financially to any great extent. One has but to think of the hundreds, if not thousands, of university professors and research workers scattered throughout this country, some of them right here on this campus, whose contributions make up the vast bulk of the scientific proceedings and communications to our various societies of learning, who are subsisting upon very small and in many cases wholly inadequate sums.

No, it is not correct to state that the urge to research is for gain. I believe it is in large part the *spirit of service.* There is inborn in every man and woman a distinct feeling to do something for some one else. This may be developed or it may be inhibited at an early age. When it is fostered and developed, it usually expands into productive service for mankind, through one of the innumerable channels. When it is inhibited, it usually fails and yet I have already pointed out to you how the true research spirit inborn in a person can overcome almost insuperable obstacles of physical and financial handicaps.

I think that all our research workers, in colleges and elsewhere, primarily are impelled by the feeling and desire to benefit the world. In other words, there is a spirit of service which is a service to both God and man. When a man dies he hopes to leave the world a little better than when he came into it. This may be through the activities of the industrialist who makes available power from unused resources, the engineer who harnesses the forces of nature, the railroad man who opens new country, the poet who unfolds new thoughts and sentiments and the beauty of life in a stimulating phraseology that reaches our listening ears, or the musician who stirs and ennobles the soul with beautiful, uplifting melody or sym-

phonic treatment of themes. Thus the research spirit is by no means confined to materialists and to material things.

It is unfortunate that the absence of the research spirit is more noticed in the phases of life other than those dealing with material developments, for it is sorrowfully true that with the tremendous material advancement of the world in the past 50 or 60 years there has not been a corresponding development of the intellectual powers with regard to the higher things of life. In spite of the decades, indeed centuries of the ever-present example of the noblest in art, there has not been a second Praxiteles. To-day we have no Rembrandts, Raphaels or Vermeers, and there is no modern Shakespeare.

We have no more "Ninth" symphonies or "Unfinished" symphonies and that tinkling tune "Yes, we have no bananas" will not make up for their loss, although the entertainment of those who enjoy that type of so-called music *may be* and unfortunately only too frequently *is* fully satisfactory. It is perhaps surprising that with our increased knowledge of resonance and the elasticity of metals and woods, there is still no substitute for the Stradivarius violin, though we have been inflicted with the saxophone. Here we have immediately a great research problem upon which we may study and reflect and should *act*, as to why is our esthetic, musical, artistic and spiritual life not more progressive? Without development there is stagnation and death, and to avoid this the entrance into our lives at every point of the spirit of research and service is essential, and this service can not be confined solely to the advancement of our material welfare, but its broader aspect must continually be kept in mind.

The recent step of your university in starting the new issue of Maine Studies, the first number of which has just come off the press and which contains a highly creditable discussion of earlier American literature, is most worthy of support from every quarter.

While the commercial returns of research are, as we have seen, oftentimes of great magnitude, the main objective for the research student must invariably be research for *the sake of knowledge*. It has long been accepted that universities must contain research centers, and students sat at the feet of Basil Gildersleeve not in the prospect of immediate rewards or riches but to draw from his fountain of knowledge. Why did students beat upon the doors of the laboratory of Louis Agassiz and why did his son, Alexander Agassiz, after the acquisition of great wealth in business enterprises, devote a large part of his life and fortune to research? The answer is "for knowledge." Certainly those of us who have enjoyed the advantages of a college education must realize that our responsibilities are consequently greatly increased, and we must see to it, for it will be through our efforts, if through any one's, that the research spirit, which is inherent in every college professor, is not too much inhibited or restricted by disadvantageous conditions. We surely can all support the research spirit and the necessity for research centers in our universities, and I firmly believe we should carry this further and emphasize the importance of the research spirit in our high schools and grammar and district schools. Bring this once effectively into play and the returns will be enormous. Obviously we can not alter the entire educational system of the state of Maine by attempting to add to an engorged curriculum or to overburdened teachers. Research above everything is not upsetting existing order. It is invariably to better the order. The old injunction "to prove all things and to hold fast that which is good" again breathes of the finest types of research spirit.

But one of the most important, if not the most important factor and result of the research spirit is its inherent tendency to develop initiative. This is of enormous educational value. In modern life there is a spirit of advance, the spirit of expectation, the spirit of hopefulness coupled with an intensity of purpose that is at times almost terrific. If this can be so directed as to develop to the fullest degree the initiative of every man, woman and child, we have the spirit of research filtering into daily life in ideal manner.

When the college graduate leaves the university halls and goes out into the world to make his way, he is immediately confronted with a situation that is strange and to which he must rapidly adjust himself. In just so far as he has been compelled to adjust himself to new environments successfully in his university career, just so successfully will he adjust himself to his new environments in his business or educational or professional career. Successful research is based wholly upon the adjustment to a new condition, a new environment. "The Occasion Instant." "Decision Difficult." Hence, personally, I have always looked with greatest favor upon all phases of academic life that necessitated such adjustments. For example, what could be more ideal for such training than the fine-grained, high principled college athlete entering into his competition clean as a hound's tooth, with the spirit to win, but with a game spirit if he loses? He adjusts himself to all possible new situations and at every period of the mile run, at every moment of the football or baseball game, the situation changes and new adjustment is necessary. Successful and rapid adjustment to this situation is the largest factor in success. If under these conditions he is fortunate enough to come out and win, no one will deny him his good fortune.

There can only be one winner, and there are lots of losers. I think that a good paraphrase of the proverb that "a good name is rather to be chosen than great riches" would be "a good loser is rather to be greeted than a vain-glorious winner." There is something fine in seeing a man take defeat in a good spirit.

We have, then, in good, clean competition, in sports, an ideal illustration of one of the fundamentals required for the best development of the research spirit, that is, the quick, successful adjustment to a new situation and environment. One of the most interesting and at the same time most important illustrations of this was developed in the late war, when the call came for doctors to go to Europe in the field. Who were the most successful doctors in the emergencies on the European battlefields? Not the great specialists of the large city, not the man whose practice was confined to office and consultations, but as a matter of fact, the country doctor showed up better than anybody else, for no one has more often to adjust himself to a new situation and an emergency than has the country doctor. The resourcefulness shown by the average country practitioner is marvelous. Could this only be directed into some research channels, the country doctor would surpass many of his hand-picked, city-bred colleagues.

Finally, we must immediately get over the idea that practical, successful research is confined to large institutions, for only too frequently does the individual amateur scientist through well-planned studies make important discoveries. The "gentleman farmer" often makes very considerable advances to our knowledge of agriculture. The importance and dignity of agriculture as a phase of economic and, indeed, cultural life, is only beginning to be felt. On the great seal of the U. S. Department of Agriculture it is stated that "agriculture is the foundation of manufacture and commerce." The great advances for the sustenance of man, his food supply, without which he can not live, the utilization of material hitherto impossible for human consumption, the scientific breeding, feeding and development of domestic animals, all are now being attacked with one of the finest organizations of research workers existent in the entire world. The United States may well be proud of its marvelous system of agricultural experiment stations, and whatever else the legislators in Washington have done, past and present, one must be thankful that they were once farsighted enough to provide large, regular appropriations such as the Hatch and Adams funds for agricultural research. Furthermore, they were wise enough to stipulate that these funds be used for research purposes only.

This idea of agricultural research had its inception years ago in Germany, where they early recognized the fundamental importance that agriculture must play in the economic life of the nation. While their agriculture had developed enormously, it could not of itself save them in their great crisis, but while their economic and sociological reverses are making heavy inroads upon their population and the health of their children, their scientific agriculture and their scientific puericulture can be but the admiration of every one who has had an opportunity to examine them.

To consider how research permeates into every field of human endeavor would be altogether too time-consuming, and we must be satisfied with accentuating the fact that without research there is no life, for to revert to the primitive man would, judged from our present standards, not be life, it would be mere existence. In every way, therefore, it is incumbent upon us as citizens of this country, as educated men and women, to give our strongest support to all educational movements which involve the development of the research spirit. In so doing not only will we have intellectual results of the most striking nature, but we have the added, if needed, incentive of the possibilities of considerable material reward and financial profit. But far above this is the inculcation of a broad and liberal spirit of progress and recognition of a necessity for adaptation to environment, to live with our neighbors, to adjust ourselves to situations as they arise from day to day, and to carry this to national existence, for we must exist with other peoples.

Even in the midst of wars we find research men ready to receive their fellow research men, even though the statesman and politician be at loggerheads. One can do no better than to quote the words of Sir Humphry Davy. In 1807 a French delegation went to London to present a medal to Sir Humphry Davy, while war between the two countries was in progress, and Davy, in receiving the medal, said: "Science knows no country. If the two countries or governments are at war, the men of science are not. That would indeed be a civil war of the worst description. We should rather through the instrumentality of men of science soften the asperities of national hostility." It was my great privilege but a few months ago to witness a similar incident, which I feel should put to shame many of us in our mental attitudes toward our former enemies. Ten months ago a great international Congress of Physiologists, including of course a large number of medical men, was assembled at Edinburgh. The committee, in preparing the invitation for this gathering, were at first in doubt as to whether the scientists of the Central Powers should be invited or not. The British Physiological Society, with characteristic British generosity, voted unanimously, as I under-

stand it, to have this invitation extended. The invitation was sent, but unfortunately, owing to the rate of exchange and the impoverishment of the nation, the Germans could not accept. One of the German professors told me it would cost him three fourths of his yearly salary to go to Edinburgh and return. In Edinburgh there was a group of public-spirited citizens who, casting aside all recollections of the horrors and sufferings of the recent war, men and women who had, I think in every instance, lost some immediate member of the family, as a result of the war, backed up this invitation to the Germans by sending a personal invitation to each German to be their house guest while in Edinburgh and furthermore a subscription was raised and three English pounds sent to each man.

Twenty-five came. I talked with many of them. I never saw a greater sense of deep appreciation exhibited by a group of men in my life. They told me they had been taken into the households of these people, had been given every courtesy, had been fed as they had not been fed in years, and I am sure that every one of these twenty-five men went back to their home land, to their classes, lecture halls and their students with warmer and deeper feelings for their former enemies than ever before, feelings that must through educational channels permeate deeply into civilian life. If these people in Edinburgh who had suffered so terribly as a result of this great conflict had breadth of human spirit enough to open their arms, take to their bosoms, into their houses, and have them break bread at their tables these representatives of their former enemies, forgetting all past offences and worshiping conjointly with these people at the shrine of that great science, physiology, how can we, thousands of miles away from the source of conflict, scarcely touched by the terrors of war, how can we, I say, consistently harbor in our hearts embittered feelings against a struggling people, struggling against a horrible self-inflicted blow. The magnanimity and humility and brotherly love exhibited at this great meeting of scientists showed me as never before that research knows no country. All are working for the best and for the advancement of mankind, and the infusion of the research spirit throughout our entire educational system can not, in my judgment, make except for a wider-visioned, better and more tolerant nation.

FRANCIS GANO BENEDICT
CARNEGIE INSTITUTION OF WASHINGTON,
BOSTON, MASS.

WHAT IS THE LARGER MEANING OF THE VITAMINE TYPE OF ACTION?

So recent, so startling and, in a way, so bewildering are the discoveries concerning substances which, like vitamines and hormones, produce such astonishing results in proportion to the quantities involved that nobody, not even those to whom belongs the credit for making the discoveries, seems to have had time to consider very much how the substances tally with others much better known in their relation to the phenomena of living beings.

If we view the apparently certain dependence on vitaminic action of metabolism and of conception in sexual reproduction, two of the most basic of all life processes, in the light of the universally held tenet that all such processes involve the transformation of matter and energy, an extremely far-reaching question easily formulates itself: Does such dependence mean that organisms have no power to utilize physiologically the potential energies either of the substances of their own bodies or of the foreign substances ingested by them, except through the activation of these energies by substances more or less of the vitaminic type or by changes of external condition of some kind?

It certainly looks as though a conclusion of this sort is being forced upon us. But if such is the case it is hardly possible to avoid pushing the question on from the realm of physiology to that of psychology. Within the realm of psychology, or better of psychobiology, the phenomenon of stimulus and response, definitive for the whole of life, first presents itself for consideration alongside the type of action in question. And it is important to note that stimulus and response almost certainly constitute fundamentally one of those inseparable couplets, like time and space, which we are coming to see enter largely into the make-up of the universe.

Our question then forges ahead inevitably until it covers the whole range of phenomena from those connected with the reflex arc fundamental to much of animal life, to those connected with the neural, muscular and glandular systems as represented in the highest brute and human animals.

One close-at-hand possible nexus between the stimulus and response type of phenomenon and the vitamine type is furnished by the conditioned nature of the beginning of individual development from the germinal stage of all organisms that exist part of the time in this stage.

The evidence is now overwhelming that the germs of no organisms whatever are able to start by their own inherited energies on their developmental careers. Their potentialities must be activated by something external to themselves either by contacts with other bodies or by changes of condition of the surrounding bodies. The numberless researches of the modern period on fertilization point unequivocally to this conclusion. The major point of the whole matter here is more the powerlessness of latent energies to

actualize themselves than what particular activating influences may turn the trick.

How far, now, does this sort of thing hold in living nature? Is it possible that all organic stimulus without exception comes under this principle? Indeed may it not be that exactly what we mean by such a stimulus is an activation of potential energies of some kind possessed by the stimulated organism? It would undoubtedly be permissible to look, for example, on the energies of all muscles and glands, so far as these organs approximate complete quiescence in the living organism, as being in a state of potentiality and requiring their appropriate stimuli (typically nervous) to change them to the state of actuality.

And from this standpoint while heredity is not, indeed, a "mere abstraction," *i.e.*, something that "does not actually exist," as a few thoughtful biologists have pronounced it to be, yet it is a "mere potentiality." And since, like all other potentialities, it is powerless to actualize itself, the whole long series of activating stimuli, without which there is no development at all, stands forth as external or environic influences of great positiveness and importance. According to the questioning here being indulged in, it would seem to be quite wrong to assume, as we are inclined to, that the initial stimulus of fertilization is the only one necessary to accomplish the development of the individual.

Again, if this dependence of life processes on the activation of potentialities by external agencies is really as far-reaching as all signs indicate, the question of its meaning for the processes we call mental, psychic, spiritual, become urgent and almost staggering. For instance, what possibilities are held before us of removing finally all doubts as to the scope and real place of sense experience in human life? For one thing the obviously correlative facts of the complete immobility of the nervous mechanism and the very special and highly efficient mobility of the muscular mechanism strongly suggest that the former somehow embodies organic energy in the latent state, so far as animal activity is concerned, while the latter presents it in the active state. And specially significant in connection with the suggestion here made is the strong tendency in present-day psychobiology to look upon the two systems, the nervous and the muscular, as not really two systems, separate and independent, but as one system, the neuro-muscular, with two distinct parts.

Having pushed our questioning thus far with gleams of light all the way we are encouraged to go still further and ask whether the problem of consciousness itself stands any chance of being illuminated by the potentiality-actuality-activation principle.

Now any one who has given this problem much attention is pretty likely to be reminded by this extension of our question of the theory propounded a few years ago by W. P. Montague that consciousness *is* energy in a latent state.

So far as I know there has never been anything presented which would correspond in the Montague theory to the activation phase everywhere implied in our questioning. But so far as it goes this theory is highly interesting from the standpoint of this note, especially if organic potentiality be not conceived as absolute inactivity but only as motor and translatory inactivity. Molecular, intracellular activity in any degree might be assumed and thus would fall in well with the high rate of metabolism observed in the brain.

The subject brought before us by these reflections is so vast that a communication like this can, of course, be nothing more than the barest touch upon its hem.

Even so, perhaps enough has been said to justify an attempted definition of a living animal creature that is rather strikingly different from the usual run of these attempts: Such a creature is a vastly complex organization of substances some of whose energies are always in the active state while others are in the latent state, the organization being such as to enable the creature constantly to alter more or less the relation between the two states of its energies in accordance with its needs, present and prospective; being able, in other words, to respond adaptively to the stimuli to which it is subject.

Nor is the questioning upon which we are launched able to find a permanent resting-place on the high road from psychobiology to philosophy. For, be it noticed, if the "stimulus-response polarity" plays the basic part in all life that is strongly intimated, then are we humans part and parcel of the system of nature not only through the bonds of the substances and energies by which we act at all, but also through the bonds by which we act consciously and intelligently. And since the source of the stimuli which condition our conscious and intelligent lives is limitless in extent, so far as we know, literally and not figuratively do we "live, move and have our finite being" in a universe that appears to be infinite in both space and time.

WM. E. RITTER

YACHT "OHIO"
July 21, 1924

SCIENTIFIC EVENTS

A SOCIETY TO PROMOTE CULTURAL RELATIONS BETWEEN ENGLAND AND RUSSIA

A SOCIETY for Cultural Relations between the Peoples of the British Commonwealth and the Union

of Socialist Soviet Republics was founded recently in London. The objects of the society are: (1) To collect and diffuse information in both countries on developments in science, education, philosophy, art, literature and social and economic life; (2) to organize lectures and an interchange of lecturers, conferences, exhibitions, etc., and to arrange for the publication and translation of papers and books; (3) to provide opportunities for social intercourse; (4) to take any action deemed desirable to forward the intellectual and technical progress of both peoples. This we learn from *Nature* from which we print the following:

Russia has unfortunately been cut off from all other civilized countries for about ten years, owing to the war and the revolution which followed it. Only in this year has it been possible to break down some of the wall separating Russia from other peoples. Through the crevices Europe begins to see that, in spite of the most difficult conditions prevailing in science and art, the great spirit of Russia is still alive and even active. Hunger, shortage of necessary technical materials, apparatus and books, the necessity of working in rooms and laboratories where the temperature in winter was near freezing-point, prosecution by the government—all this has not killed the spirit of Russia. The attempts of the government to proletarianize science and art have not been very successful for a simple reason, namely, there is only one truth, the same for proletarians and bourgeois, the desire for which is that peculiar feature which distinguishes a man from an animal. For Russians the breaking down of the wall surrounding their country has become much more important than for countries which are outside this wall: the development of western science, art, literature, philosophy and social life, which is free and not "controlled" by government and has proceeded under normal conditions of life, has resulted in remarkable progress. There is no need to point out how vital the knowledge of this progress is to Russia. From this point of view, it is necessary only to wish all success to this new society, provided it does not become an official organization, but remains free from any official control and concerns itself only with the promotion of friendly relations between the intellectual representatives of both countries.

RESURVEY OF NIHOA AND NECKER ISLANDS

During 1923 the Tanager Expedition, under the joint auspices of the United States Navy, the U. S. Biological Survey and the Bernice P. Bishop Museum, made a scientific survey of the chain of islands extending from Hawaii, 1,000 miles northwestward to Ocean Island. A corps of nine scientists, assisted by experienced collectors and by the officers and crew of the U. S. S. *Tanager,* carried on investigations in marine zoology, botany, entomology, ornithology and geology for five months. Somewhat unexpectedly ruins of ancient settlements were found on the islands of Nihoa and Necker. These two islands are eroded remnants of volcanic masses, cliff-bound and without water. On them a landing party made collections and maps, but had neither the time nor the facilities for an exhaustive study of the archeological remains.

During July of the present year, the United States Navy again provided the *Tanager* and with a selected navy personnel and a group of scientists from the Bishop Museum, under the direction of Professor Harold S. Palmer, the ship returned to Nihoa and Necker equipped for making topographic maps, sketches and photographs showing the location and character of the walls, house platforms, terraced fields and burial grounds. With considerable difficulty, land camps were established and the surfaces of the islands cleared of brush, revealing ruins favorably placed for study.

As compiled by Kenneth P. Emory, ethnologist of the Bishop Museum staff, the Nihoa maps show fifty structures within an area of about 130 acres—house platforms, temple sites, garden terraces; the Necker maps show only ruins of places used for religious purposes. The collections from these islands include stone bowls, stone idols, adzes, hammerstones and other artifacts, and skeletal material from burial caves. Although Nihoa Island is only 160 miles from Kauai, the stone structures and the skeletons show forms not common to the inhabited islands of the Hawaiian Archipelago.

FIRST PAN-PACIFIC FOOD CONSERVATION CONFERENCE

The first Pan-Pacific Food Conservation Conference met at Honolulu, from July 31 to August 14, 1924, under the able chairmanship of Dr. L. O. Howard, chief of the Bureau of Entomology of the United States Department of Agriculture. Ninety-five of the delegates came to Hawaii for these meetings—thirty-eight from mainland United States, fifty-five from other Pacific countries, and two from the West Indies. Twelve duly constituted delegates from Hawaii and thirty-six residents of Hawaii participated in the meetings which were also attended by a considerable number of local laymen. Strong delegations were sent from French Indo-China, Japan and New South Wales. Altogether fourteen Pacific countries were represented by about a hundred and forty technical men and women.

The conference, which was the fifth designed for promoting the mutual understanding by peoples of the countries around the Pacific of one another's problems, was called by and held under the auspices of the Pan-Pacific Union. A very important result of the conference, and one difficult to measure, was the

broadening due to close contact between delegates from many regions. An appreciation was obtained by many of problems which are not widely realized though of vital importance to their immediate localities.

The conference was organized in seven sections, the most active of which were devoted to (a) the sugar-cane industry, (b) fisheries, marine biology and oceanography, (c) plant protection through quarantine and researches in entomology and pathology and (d) food-crop production and improvement. As a result of the deliberations of the section on the sugar-cane industry, there was tentatively organized an international association of men interested in the sugar-cane industry, which it is hoped will meet in Havana in 1927. The other sections have also provided continuation committees.

At the final sessions thirty-three resolutions were adopted. Three resolutions relate to the sugar industry, six to fisheries, four to plant protection, one to animal industry, four to food crops, three to marketing problems and the rest are of a more general nature. Classifying the resolutions on a different basis, three refer to the work of the Pan-Pacific Science Congress to be held in Japan in the autumn of 1926, six to protection of food resources by international treaties and agreements and twelve recommend more or less specific programs for future research.

The committtee on publication appointed by the conference plans to publish a report of the proceedings which will include abstracts of the papers transmitted, list of delegates and the like. It is expected that many of the papers will be published in full in journals devoted to special fields of science.

HAROLD S. PALMER,
Secretary of the Conference

COOPERATION IN SEISMOLOGY

AN agreement has been reached to promote seismological research in both scientific and practical lines between the Carnegie Institution of Washington, through its advisory committee in seismology, and the Seismological Society of America. The first-named is a research organization, which pursues the policy of publishing its results in any particular journal that will reach the largest number of readers interested in a given subject. The second is a society dependent on its members for support and engaged in publishing a journal (*Bulletin* of the Seismological Society of America), which is designed to form a means of communication among seismologists and to serve as a medium of education for the general public in matters relating to earthquakes and allied phenomena. It is obvious that these two organizations may advantageously cooperate.

The advisory committee in seismology was appointed by the institution four years ago with the specific purpose of organizing investigation in the field of seismology. After considering the extent and character of the field, the committee recommended "taking up at the outset the pressing problem offered by the West Coast region of the United States, where earth-movements in considerable variety occur and so little is known about them that they constitute a tangible menace to large engineering and other development enterprises and sometimes to human life." (Report of the Chairman for 1921.)

If this selection of a province seems geographically limited the fruitfulness of the region in problems may be indicated by a further quotation from the report cited, bearing on the organizations drawn into the work. The report continues:

"It was recommended that the Institution invite the participation of a number of agencies, through the cooperation of which an adequately comprehensive attack might be inaugurated and competent conclusions assured." Accordingly the Ukiah and Lick Observatories were invited "to continue and extend their observations of latitude for the purpose of establishing (or disproving) a northward crustal creep or drift, which had been indicated by earlier observations." The U. S. Coast and Geodetic Survey was invited to resurvey and extend "its system of primary triangulation and precise levels until no considerable area within the various zones of movement in California can suffer displacement without the possibility of establishing its direction and magnitude." The U. S. Geological Survey, in collaboration with the California universities and geological societies, was asked to "organize geological studies of the regions in which the more active faults occur. Several organizations "were invited to aid in the development of instruments more suitable than any now in use for recording and analyzing local slips and tremors. And finally, the Navy Department undertook deep-sea soundings off the west coast of California to establish the precise location of the continental shelf and any conspicuous fault scarps adjacent to the land areas in which active faults are found.

Without exception the initiative of the advisory committee was welcomed by the organizations invited to participate and important results have already been reached. Among the more definite accomplishments we may mention the Fault Map of California, published by the Seismological Society, the Bathymetric Chart of the Continental Shelf from San Francisco to Point Descanso, published by the U. S. Hydrographic Office, a new primary triangulation of the entire coast region south of San Francisco by the U. S. Coast and Geodetic Survey and the successful development of a new type of torsion seismometer of low first cost and general application by Messrs. J. A. Anderson and H. O. Wood, working in the laboratories of the Mt. Wilson Observatory at Pasadena.

The influence of the advisory committee in promoting cooperation is now extended to the Seismological Society of America. That society, organized in 1906 and publishing since 1911, has for its objects the advancement of seismological research and the promotion of human security against earthquakes and earthquake fires. It has carried on its work with slender means, with a membership of about four hundred, including interested laymen as well as seismologists, widely distributed in all the continents. Recently its membership has increased by more than fifty per cent., and it seeks to increase it still further in order better to serve its objects. The agreement with the advisory committee in seismology provides that the latter shall assist, temporarily, in the publication of the *Bulletin* of the society by meeting the cost of publishing specific articles which the society could not otherwise undertake.

The guarantee of this financial support is of such a nature that the Seismological Society may and does extend an invitation to workers in the field of seismology and related zones of research to use the *Bulletin* as a means of communication with fellow workers in all lands. In considering the scope of the field of seismology and related zones of research within which it may advantageously serve its scientific circle, the *Bulletin* will lean toward a liberal interpretation, with due regard for the established journals in meteorology, chemistry and physics. Its interest centers in the dynamics of the earth, but extends to allied researches which may throw light upon that comprehensive field of activity.

Another phase of the *Bulletin's* interest comprehends the practical side of earthquake studies. The world-wide occurrence of earthquakes means that there is world-wide experience of their effects, acquired at the cost of enormous values destroyed and great loss of life, but so scattered, ignored or suppressed that it is ineffective to serve humanity at large. The records of that experience await assembling, discussion and interpretation for the benefit of communities in all trembling lands.

Furthermore, there is great need of education of the intelligent public to take earthquakes out of the realm of astrology and rob them of that mystery which is one of their most potent attributes for mischief. Articles dealing with the facts of earthquake activity in relation to human affairs, addressed to men of affairs, in language intelligible to the educated reader will also be welcomed by the *Bulletin.*

Correspondence with the chairman of the Committee on Publication, Professor S. D. Townley, Stanford University, California, is invited from all who may be interested, either in publishing the results of seismologic studies or becoming members of the society. Articles intended for publication may be written in English, French, German or Italian. Publication will be in English, but if the foreign author should wish to supply an abstract in his own tongue, it may be printed in any one of those languages.

Arthur L. Day, *Chairman*
Advisory Committee on Seismology, Carnegie Institution of Washington,

Bailey Willis, *President,*
Seismological Society of America

SCIENTIFIC NOTES AND NEWS

At the conclusion of the meetings of the French Association for the Advancement of Science, the University of Liége conferred honorary degrees on M. Raymond Poincaré; Dr. Rigaud, director of the Paris Radium Institute; Dr. Lacroix, secretary of the Paris Academy of Sciences; Dr. Paul Sabatier, professor of chemistry at Toulouse; Dr. Marcellin Boule, professor of paleontology at the Natural History Museum, Paris; Dr. Henri L. Le Chatelier, professor of chemistry at Paris; Dr. Charles Barrois, professor of geology and mineralogy at Lille; Dr. Paul Shorey, professor of Greek at the University of Chicago.

At a special convocation of the University of Toronto, held on August 13, on the occasion of the meeting of the British Association for the Advancement of Science, the degree of doctor of science, *honoris causa,* was conferred on Sir David Bruce, president of the British Association; Sir Ernest Rutherford, retiring president, Cavendish professor of physics at the University of Cambridge; Sir John Russell, director of the Rothamsted Experimental Station, and Sir Charles Parsons, chairman of the Parsons Marine Turbine Co., London.

The honorory degree of doctor of philosophy has been conferred, by the University of Bonn, on Dr. Frank Springer, of the National Museum.

Dr. José Casares y Gil, dean of the faculty of pharmacy at Madrid, has had an honorary degree conferred on him by the University of Munich.

Professor Salvator Pincherle, professor of infinitesimal calculus at the University of Bologna, has been elected president of the International Mathematical Union.

Dr. M. Jean Camus, professor of physiology at the Paris Medical School, has been elected a member of the French Academy of Medicine.

Dr. G. Haberlandt, professor of botany at the University of Berlin, has been elected a foreign member of the Royal Swedish Academy of Sciences.

The director of the U. S. Geological Survey rep-

resented the Secretary of the Interior at the World Power Conference, held in London, from June 28 to July 12. The Geological Survey was represented by John C. Hoyt.

PROFESSOR ALAN W. C. MENZIES, of Princeton University, has been appointed as delegate from the Royal Society of Edinburgh to the Franklin Institute on the occasion of its centenary in September.

DR. J. E. MILLS has been appointed chief chemist in charge of the research work of the Chemical Warfare Service.

DR. G. F. LOUGHLIN has been appointed geologist in charge of the section of metalliferous deposits of the U. S. Geological Survey to fill the vacancy caused by the resignation of Dr. F. L. Ransome. F. J. Katz has been made geologist in charge of the division of mineral resources, the position vacated by Mr. Loughlin.

PROFESSOR MAX A. MCCALL, formerly superintendent of the Adams Branch Experiment Station, Lind, Washington, and more recently in the division of agronomy of the Washington Agricultural Experiment Station at Pullman, has been appointed agronomist in the office of cereal investigations of the Bureau of Plant Industry, U. S. Department of Agriculture.

DR. T. S. TAYLOR, since 1917 in charge of Insulation Research with the Westinghouse Electric and Manufacturing Company, has joined the research department of the Bakelite Corporation, and will have his headquarters at Bloomfield, New Jersey, at the new research laboratory now in process of construction.

SCIENCE Service, Washington, D. C., announces the addition to its staff of Dr. Frank E. A. Thone and Dr. James P. Kelley. Dr. Thone was formerly assistant at the University of Chicago and Johns Hopkins University, as well as assistant professor of botany at the University of Florida. He will direct the *Daily Science News Bulletin* which Science Service furnishes to newspapers. Dr. Kelly, who holds degrees from Princeton and Columbia, goes to Science Service from the Pennsylvania State College. He was for a time assistant editor of *Botanical Abstracts.* He will devote particular attention to the half-page science features.

DR. EUGENE C. TIMS has been appointed assistant pathologist at the Louisiana Agricultural Experiment Station, Baton Rouge, La.

PINGJAN TSIANG has been appointed director of the observatory at Tsingtao, which has been handed over by Japan to China.

GEORGE C. MARTIN, geologist in the Alaskan Branch of the Geological Survey, resigned on July 1.

DR. W. A. TARR, of the University of Missouri, will spend the coming year in Europe on sabbatical leave of absence. He expects to carry on his studies of chrit, stylolites and related features of sedimentary rocks, as well as visit the more important mineral deposits. A part of the year will be spent in the laboratories of Dr. R. H. Rastall, at Cambridge University.

THE Paris correspondent of the *Journal* of the American Medical Association writes that at Saint Christophe, his native city, a monument was recently unveiled in memory of Professor Raphael Blanchard, who died in 1919. Addresses were delivered by Dr. Doléris, president of the Academy of Medicine; Professor H. Roger, dean of the faculty of medicine of Paris; Professor Lapersonne, and others. The speakers referred to the progress that Blanchard had brought about in parasitology; the part that he had played in the establishment of the Institute of Colonial Medicine and in the Société de Zoologie, which he helped to found and which he served for twenty-two years as general secretary, and in the Société d'Histoire de la Médicine, of which he was also one of the founders.

DR. BERTRAM WELTON SIPPY, professor of medicine in Rush Medical College and the University of Chicago, well known for his work on the diseases of the gastro-intestinal tract, died on August 15 aged fifty-six years.

DR. JOSEPH ELLIOT GILPIN, professor of chemistry at the Johns Hopkins University, has died aged fifty-six years.

DR. OLIVER W. HUNTINGTON, formerly instructor of mineralogy at Harvard University, has died, aged sixty-six years.

SIR WILLIAM MADOCK BAYLISS, professor of general physiology in University College, London, died on August 27 at the age of sixty-four years.

PROFESSOR JULIUS WERTHEIMER, professor of applied chemistry and dean of the faculty of engineering at the University of Bristol, died on August 9, aged sixty-four years.

DR. JOSEF HERZIG, emeritus professor of chemistry at Vienna, and member of the Vienna Academy of Sciences, has died at the age of seventy years.

DR. EDOARDO BASSINI, senator and emeritus professor of surgery at the University of Padua, has died at the age of eighty years.

THE eighty-eighth annual meeting of the Association of German Scientific Men and Physicians opens

on September 24, in connection with a scientific exhibit at Innisbruck.

MORE than 1,000 members from universities and industrial enterprises in every state will attend the fall meeting of the American Chemical Society to be held in Ithaca from September 8 to 13. The general meeting at which the foreign chemists will speak will be held on Tuesday, September 9, at 9.30 A. M., in Bailey Hall, Dr. Livingston Farrand, president of Cornell University, presiding. A response to addresses of welcome will be made by Dr. Leo Hendrik Baekeland, of New York, president of the American Chemical Society and professor of chemical engineering in Columbia University. On the afternoon of this day the visiting chemists will inspect the Baker Laboratory, the gift of George F. Baker, of New York, under the direction of Dr. L. M. Dennis, head of the Cornell Department of Chemistry.

AT the seventy-second annual meeting of the American Pharmaceutical Association being held in Buffalo, Charles W. Holten, of Newark, N. J., was elected president; William B. Day, of Chicago, was reelected secretary, and E. F. Keyyl, of Baltimore, was reelected treasurer. Louis Emanuel, of Pittsburgh, was designated honorary president for 1924–1925.

THE third national symposium on colloid chemistry will be held at the University of Minnesota in June, 1925.

THE Viceroy of India has sent a donation of Rs. 1,000 and the Maharaja of Nepal a donation of Rs. 1,500 towards the funds being collected for the foundation of the Ross Institute and Hospital for Tropical Diseases.

AT the University of London research grants out of the Dixon Fund for the year 1924–25 have been made as follows: £50 for research on the physiological factors governing the proportions of sexes in mammals to Alan Sterling Parkes (Institute of Physiology, University College); £50 to Eric Arthur Spaul, Ph.D., to continue experiments with the anterior lobe pituitary gland, and to gain further knowledge of the properties of the active principles of this portion of the gland and also its biochemical properties (Zoological Laboratory, Birkbeck College); £50 to Florence Mary Wood, for chemicals and apparatus in connection with research upon the chemical nature of the cellulose membrane; £20 to Muriel Bond, M.Sc., for research into the dietetic factors influencing reproduction (London School of Medicine for Women).

THE Vienna correspondent of the *Journal* of the American Medical Association writes that the new university building, which had been commenced in 1914, but which could not be completed during the war, was opened on June 28. The new building succeeds the old one, which dates back to the sixteenth century, and which was antiquated. The hygienic arrangements, and the accommodations for laboratory work and for other research were sorely behind the requirements of our time. There are accommodations for administration as well as for all studies except the purely medical. The latter have to be pursued at the bedside in the old clinical hospitals. The costs of the new building were defrayed by the state, only a small percentage of the actual expenditure being contributed by the municipal and county authorities.

EIGHT new mountains have been found and ascended and the hitherto unknown Cariboo Range in British Columbia definitely located by Professor Rollin T. Chamberlin, of the University of Chicago Department of Geology, and Allen Carpe, a New York engineer. One of the peaks, yet unnamed, ranks among the highest in the Canadian Northwest. In addition to the discovery and ascent of the great glacier peaks, Chamberlin and Carpe have located the headwaters of the Thompson and Canoe rivers, the latter of which follows the Rocky Mountain trench to the Columbia River. They are the first white men ever to note the glacial sources of the two mountain streams.

ACCORDING to the *Journal* of the American Medical Association, the advisory committee on the education of sanitarians and the future of public health in the United States, of the U. S. Public Health Service, met in Washington, D. C., on July 24. Measures were discussed for providing supplemental academic training for health officers, sanitary engineers, statisticians, public health nurses, laboratory specialists, oral hygienists and other types of sanitarians now employed. According to preliminary reports presented at the meeting, several hundred persons have been in attendance this year at four public health summer schools—those conducted by Columbia University, the University of California, the State University of Iowa and the University of Michigan. Inquiries received last winter, however, indicate that a greater number wish to secure further academic training than appear to have been able to leave their work for six or eight weeks summer school. It is the hope of the Public Health Service that the universities of the country with which "Class A" medical schools are affiliated may provide in the future three kinds of facilities for the further education of sanitarians now employed. First, it is hoped that at least a few schools will be able to offer intensive courses providing for the continuous study of a single subject for the period of a month or more. Such courses are offered by the School of Public Health of Harvard University and provide an opportunity for training which requires that a sanitarian absent himself from his work for only a month at a time.

Secondly, it is recommended that universities and medical schools offer one or more courses of study with two or three hour periods once or twice a week at a time of day which will make possible the attendance of persons employed by various kinds of health agencies. Courses are now offered, of course, by a number of medical schools which would be of great value to sanitarians now employed were the availability of these courses brought to their attention. Finally, it is expected as a result of the interest demonstrated by sanitarians this year, that Columbia University, the University of Michigan and possibly two or three other institutions will conduct in 1925 public health summer schools of a similar nature.

The *Journal* of the American Medical Association states that the minister of labor has published the vital statistics for France during the first three months of 1923 and for the corresponding period in 1924: During the first quarter, the number of marriages was nearly 10 per cent. higher than for the corresponding period in 1923. The number of living births has remained about stationary; also infant mortality. The total number of deaths, however, has risen from 190,036 to 219,045, but the same thing is true of other countries. In England, for example, the number of deaths has risen from 124,720, during the first quarter of 1923, to 160,279 for the first three months of 1924. Nevertheless, the demographic situation of France during the first quarter of the current year was deplorable, since it resulted in an excess of deaths over births of 24,039, as compared with an excess of births over deaths of 6,069 in 1923.

UNIVERSITY AND EDUCATIONAL NOTES

The College of the Pacific is now moving from San Jose, California, to Stockton, California, where seven new buildings are being completed at a cost of $750,000. The science building will be well equipped for physics, chemistry and biology.

The Miners' Welfare Committee, England, has made a grant of £2,250 toward the equipment of the mining department of the Royal Technical College, Glasgow.

Mr. Blumenthal, of New York, as further evidence of his interest in French universities, has presented to the Sorbonne, Paris, a gift of 250,000 francs.

Professor A. F. Greaves-Walker, ceramic engineer, vice-president and director of the Stevens Bros. Co., Ga., has been appointed director of the new department of ceramic engineering to be established at the North Carolina State College during the coming school year.

Dr. J. A. Eldridge, of the General Electric Company and formerly of the University of Wisconsin, has been appointed an associate professor of physics at the University of Iowa.

Dr. E. F. Phillips, who has been in charge of the Beekeeping Investigations of the Bureau of Entomology for the past nineteen years, has accepted a professorship in apiculture at the New York State College of Agriculture, at Cornell University, and will begin his work there about October 1.

At Barnard College, Columbia University, Dr. Louis H. Gregory has been promoted to associate professor of zoology, and Miss Grace Sangford to assistant professor of physics.

Dr. Nicholas M. Alter, instructor of medicine at the University of Michigan Medical School, has been appointed professor of pathology at the University of Colorado.

Dr. George B. Roth, assistant professor of pharmacology in Western Reserve University, has been appointed professor of physiology and pharmacology in the George Washington University Medical School, Washington, D. C.

Dr. Herbert W. Rogers, assistant professor of psychology at the University of Minnesota, has been appointed assistant professor and director of the laboratory of psychology at Lafayette College to fill the vacancy created by the resignation of Dr. Gilliland, who goes to Northwestern University.

Professor S. Chapman, professor of applied mathematics at the University of Manchester, has been appointed professor of mathematics at the Imperial College of Science, South Kensington.

Dr. Alfred Kuhn, professor of zoology at the University of Göttingen, has been appointed professor of zoology and comparative anatomy at Munich, to take the place of Professor R. V. Hertwig, who has resigned.

DISCUSSION AND CORRESPONDENCE

NOTE ON THE RELATIVITY MOTION OF MERCURY

According to the formulas of relativity as given by Eddington the perihelion of a planet's orbit moves forward in each revolution by an amount,

$$6\pi \frac{m}{p},$$

where p is the parameter of the orbit and m, *"the gravitational mass of the sun is approximately 1.5 km."*

With this value of m, the motion of Mercury's apse-line is computed by the relativists as being 43

seconds of arc per century. But this value of m, namely 1.50 kms., depends entirely upon the choice of the fundamental units of length and time. For, in celestial dynamics, mass is a derived unit and involves the units of time and distance. This relation is well known and is given by Eddington in the form:

$$m = v^2 r,$$

where r is the distance of any planet from the sun and v is the velocity of the planet in its orbit.

This expression for the mass of the sun will become linear when v is expressed as the ratio of velocities, is expressed in terms of some arbitrary unit of velocity. The numerical value of m will, therefore, vary according as to what is assumed as 'unit velocity." But unit velocity is the distance travelled in unit time, and hence "unit velocity" depends upon the system of units adopted for length and time.

In ordinary astronomical convention, the unit of length is the distance of the earth from the sun and the unit of time is the *mean solar day*. Using this system of units, the mass of the sun, expressed linearly, becomes:

$$m = 44{,}800 \text{ kms.}$$

With the ordinary system of units of the physical laboratory, in which the *centimeter* is the unit of length and the *second* is the unit of time, this linear value of the mass of the sun becomes:

$$m = 13.5 \times 10^{20} \text{ kms.}$$

The relativity system of units, adopted by the relativists, is adjusted so as to make the velocity of light "unity": in this system, therefore, the unit of length is the *kilometer* and the unit of time is the *1/300,000th part of a second*. And in this system of units, the linear value of the mass of the sun is expressed by:

$$m = 1.50 \text{ kms.}$$

as given by Eddington.

Now, when these various values for the "linear mass" of the sun, or for the constant m of relativity, are substituted in the formula for the motion of the apse-line, the respective motions of the perihelion of Mercury in one century become:

For astronomical units,	this motion becomes 357°, or very nearly a complete revolution.
For physical units,	this motion becomes 3×10^{16} complete revolutions: or the orbit is revolving at the rate of 9.5×10^{6} complete revolutions *per second*.
For relativity units,	this motion becomes the celebrated 43 seconds of arc.

Thus, if the m in the relativity formula for the motion of the perihelion represents the *"gravitational mass of the sun,"* as stated and claimed by the relativists, then the relativity motion of a planetary orbit depends entirely upon the system of fundamental units adopted for measuring length and time; depends absolutely upon what is called "unit velocity." Can such a motion, a motion which changes with the units employed, represent a physical fact? Is it not, rather, purely a mathematical illusion, due to an erroneous interpretation of an equation?

CHARLES LANE POOR
COLUMBIA UNIVERSITY,
May, 1924

WAXY ENDOSPERM IN NEW ENGLAND MAIZE

THE peculiar type of endosperm texture in maize, familiar to geneticists as "waxy," which has previously been found only in isolated localities in China, Burma and the Philippines,[1] has recently appeared in a New England variety grown at the Connecticut Agricultural Experiment Station.

Waxy seeds were found by Dr. D. F. Jones in the fall of 1922 on two hand pollinated ears of Sanford's White Flint which were segregating in the proportion of 3 starchy: 1 waxy. Both of these ears are the progeny of a single open pollinated ear which had been received in a lot of 25 ears of this variety obtained from a farmer near Kent, Connecticut, in the spring of 1922.

The recessive seeds from one of the segregating ears were planted in 1923 and crosses were made with a waxy strain secured from Mr. G. N. Collins, of the Bureau of Plant Industry, who had obtained this type originally from Shanghai, China. When pollen from the Chinese waxy was applied to the silks of the New England waxy, only pure waxy seeds resulted, proving that the two strains are genetically identical in their type of endosperm.

As far as is known the only waxy maize ever grown in Connecticut is the Chinese strain, which has been used in genetic investigations on the experiment station farm for a number of years. No corn of any kind has ever been sent from the station to the locality from which the ears of Sanford's White Flint were obtained, and it is scarcely possible that the appearance of waxy endosperm in this variety is due to previous crossing with the Chinese waxy. Nor is there any indication that the strain in which waxy has appeared has undergone recent crossing with such a widely different sort as the Chinese strain. Sanford's White Flint is an old and well-

[1] G. N. Collins, "Waxy maize from Upper Burma," SCIENCE, N. S., Vol. LII, No. 1333, pp. 48–51, July 16, 1920.

established New England variety and the strain which carries the waxy endosperm is typical of the variety in type of plants, ears and grain.

The origin, in an American variety, of this peculiar endosperm texture, previously found only in several isolated Asiatic localities, will probably remain a matter for speculation. It may have arisen by mutation within the past few years, or it may have been carried by the stock as a hidden recessive for centuries. In any case its appearance may be regarded as a further bit of evidence against the theory of a pre-Columbian distribution of maize outside of the American continent. Nor would it be surprising if a thorough investigation, by the process of inbreeding, should bring to light waxy endosperm in a number of additional American varieties.

P. C. MANGELSDORF

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

THE METRIC SYSTEM

SCIENCE for June 13, 1924, contains a letter advocating the metric system. I can not see how the metric system can be of any greater value to the ordinary person than the present system. The decimalists are too fond of overrating their own exploits. Even with the coinage I find after 12 years residence in Canada that the money system is no simpler than the pounds, shillings and pence of England and I find with constant trading with the United States that the rate of exchange does away with any advantage which a common money system may have. And how is it that the "quarter" is so popular? It surely should not have a place in a decimal system. In my opinion a decimal system may be all right for an ignorant and unlettered community and possibly here the advocates in the United States may make a big claim for its use.

It is amusing to see Mr. McAdie claim that scientific men the world over champion and use the metric units. Apparently engineers and the engineering profession in general are not scientific. Why, even a cook[1] may be more scientific than a meteorologist. Mr. McAdie does not see that although it may be an advantage for those who "analyze" to use a decimal system such a system is of no importance to those who "manufacture." For the latter—and they are the useful people in this world—a binary system or a duodecimal system is much better.

I have been teaching physics in Toronto for the last twelve years and have introduced the English units more and more as the years have gone on because I find the students understand them better. Especially is this true in mechanics. I note what the writer of the letter says about the questions in the school arithmetics. I always imagined that they were inserted to give the pupils practice in arithmetical manipulation. I never thought that they would be used to condemn the English system. You might as well condemn Christianity because it is a hard faith to live up to.

The trouble with men like Mr. McAdie is that because they like a thing they think all the world must agree with them. They never see the other side.

JOHN SATTERLY

UNIVERSITY OF TORONTO

[1] Mr. McAdie is rather scornful of the cook who measures by cups.

PERMANENT PHOTOGRAPHS

DR. CLARENCE H. KENNEDY'S experience with platinum photographs as told in the issue of SCIENCE for July 11 is another confirmation of the permanence of this printing process. In the *British Journal of Photography* of December 24, 1909, was an account of some platinum prints recovered in October of that year from the wreck of a war vessel, after having been under the sea for more than five months. The cardboard mounts were disintegrated, and the surface paper, to which the prints still adhered, was ruined by the water. But the prints themselves were bright and clean as if freshly made.

Present day photographers, spoiled by the ease and convenience of modern photographic processes, may think platinum printing difficult, but it used to be regarded as very simple and easy. The paper is partially printed by daylight or electric arc, and developed in a solution of potassium oxalate and potassium phosphate. It is then passed through three acid baths, and finally washed in water for 15 minutes, the whole procedure of developing, fixing and washing taking only about half an hour. The resulting picture is, Dr. Kennedy says, as permanent as the paper on which it is printed. If the print has not been properly "cleared" in the acid baths, the paper may in time turn yellow, but the discoloration is easily removed with a bleaching solution of acidified hypochlorite without affecting the platinum image. The chief drawback to the use of platinum paper is its high price.

CHARLES MACNAMARA

SCIENTIFIC BOOKS

Galapagos: World's End. By WILLIAM BEEBE. G. P. Putnam's Sons, New York and London, 1924, xxii + 443 pp., with 24 colored illustrations by Isabel Cooper and 83 photographs, mostly by John Tee-Van. Published under the auspices of the New York Zoological Society.

SINCE the publication of "The Voyage of the

Beagle" Galapagos has been a name with which to conjure up vistas of weird reptilian life, giant tortoises, strange marine lizards, of finches and hawks unaffrightened by man and of a marine life brilliant and varied such as only the tropics can produce. Expeditions have come and gone from these volcanic wastes and have reported their biological finds with elaborate technical detail and an ever-increasing confusion of interpretations as to the species limits and relationships of the isolated faunas of the various islands of the archipelago. Save for the herpetologist, ornithologist, coleopterologist or other specialist or for the student of the many problems of evolution, geographical distribution, isolation and animal behavior, these analytical reports make dry reading, not so Mr. Beebe's "World's End."

This entertaining work is the outcome of an expedition on the private yacht "Noma" to several islands only of this large archipelago in 1923. In all less than one hundred hours were spent in exploration, mostly on five of the smaller islands of the group, Eden, Guy Fawkes, Daphne, Seymour and Tower. Excellent use was made of the time, however, and the story of adventure amidst the turbulent breakers, lava cliffs and slopes, cactus and thorn and shelly beaches loses nothing of interest at the hands of this facile, brilliant and sympathetic interpreter of nature and life.

The author is keenly alert to the biological problems involved in the adaptations exhibited by the species of animals inhabiting these waste and desolate desert islets and islands. The margin of existence is narrow, and liable to temporary and local interruptions by slight disturbances in the balance of nature. Man and the animals introduced by him have been the great disturbers. The giant tortoises are even now partially exterminated and will not long survive unless protected. On the other hand, the absence of marauding mammals in the native fauna has exempted the birds from the selective action of this factor operative on their mainland relatives.

The reviewer well remembers his impressions of the finches on Chatham Island in 1905 when the U. S. S. *Albatross,* then en route on the Agassiz Expedition to the Eastern Tropical Pacific, lay at anchor at Wreck Bay. In the thorny scrub which covers the lower slopes of that blackened, lava-strewn island the most conspicuous objects are the numerous black finches, recalling in color though not in size our own crows and blackbirds. Every vestige of protective coloration in their plumage is eliminated. Add to this the astounding lack of fear which they exhibit and the impression is overwhelming that the presence of mammals in the animal associations of any region is a potent factor in both the structure and behavior of the birds. Wild dogs ranged in the Chatham Island scrub, but they are so recent as apparently to have wrought no changes even in the behavior of the finches. One could call them up in great numbers. They would perch close at hand, even on his hat and shoulders, with freedom and seeming curiosity but without fear. Dr. Beebe notes the results of this cessation of selection in the abundance of other erratic features, such as the frequent irruptions of partial albinism and unusual behavior in breeding. Structurally one finds an orthogenetic development of bill in these finches of the Galapagos. The bill is already abnormally large in finches generally, but it is excessively large in certain species and is progressively developed among those of the Galapagos to extremes which far exceed the bounds of necessity and apparently of utility.

The book is rather sparingly illustrated but with fine taste and skill. The text likewise has esthetic qualities of rare value. The reader shares the zest of exploration, is spellbound by the tragedies of the tropic seas, with their teeming fish and bird life, and of the castaways of long ago from distant shores stranded on these desert islands.

CHARLES A. KOFOID
UNIVERSITY OF CALIFORNIA

SPECIAL ARTICLES

THE INDUCTION OF GROWTH PROMOTING AND CALCIFYING PROPERTIES IN A RATION BY EXPOSURE TO LIGHT

IN verifying the work of Goldblatt and Soames who observed that livers taken from rats irradiated with light possessed growth promoting properties—which were not possessed by livers taken from non-irradiated rats—it was found that a growth promoting property could be conferred upon muscle tissue by illuminating it after its removal from the body. It was also found in another series of experiments that irradiated rats put in the same cage with non-irradiated rats were able to induce growth in the latter.

Proceeding on the assumption that failure of growth on our basal synthetic rations without the effect of illumination was due to a condition fundamentally the same as rickets, experiments were initiated in which our basal synthetic ration of purified food materials was illuminated and then fed to rats. Here also illumination of the ration caused it to become growth promoting and, in addition, it was found that the ash content of the bones of rats receiving such a ration was increased percentagely over that of rats receiving the non-radiated ration. Later it was also

found that irradiation of fats, otherwise inactive in preventing rickets, caused them to become active and that rations which ordinarily produced wide rachitic metaphysis in the shaft bones of rats became antirachitic and promptly effected a rapid and complete healing of the lesion.

These facts have now been correlated with what is known of the properties of the antirachitic vitamine and found in substantial agreement. As a result of this experimental work, the action of direct irradiation and the reported antirachitic action of irradiated air has also become understandable to us from a different point of view.

These experiments, which have been in progress since November, 1923, will be reported shortly in the *Journal of Biological Chemistry*. In the meantime, to protect the interest of the public in the possible commercial use of these findings, applications for Letters Patent, both as to processes and products, have been filed with the U. S. Patent Office and will be handled through the University of Wisconsin.

H. STEENBOCK

LABORATORY OF AGRICULTURAL CHEMISTRY,
UNIVERSITY OF WISCONSIN

ON THE EFFECTS OF VARIATION IN FREQUENCY OF STIMULATION ON STRIATED, CARDIAC AND SMOOTH MUSCLE[1]

DURING the course of an investigation carried out by one of us on the effects of variation in frequency and intensity of stimulation of the vagus nerve on the lower end of the esophagus, the cardia and the fundus et corpus ventriculi of the cat, concerning which a preliminary note has been published,[2] it became desirable to extend experiments of this kind to direct stimulation of the different types of muscle. Accordingly, we have chosen for investigation the m. gastrocnemius of the frog, the m. omohyoideus of the turtle, the apex of the turtle's ventricle, portions of the alimentary canal of the cat and the siphon muscle of the clam. The results, which have corroborated those obtained in the vagus experiments, are here reported in a second preliminary communication.

Considering first striated muscle, frequencies of interruption of the primary current of about 40 per second cause pronounced and well-maintained tetanus of the frog's gastrocnemius and the omohyoid of the turtle, but an increase in frequency to 100 per second or more causes more or less complete relaxation. If the higher frequencies are employed at the outset, the muscle responds with a rather brief initial tetanus, relaxation taking place thereafter. The effects are most clearly obtained from the omohyoid of the turtle, for it has much less tendency to enter into a state of contracture than the gastrocnemius. These results are obtained from the curarized as well as the noncurarized muscle.

In case the stimulation is long continued, the gastrocnemius begins to contract rhythmically. This occurs best with a frequency of about 40 per second. The contractions are slowed in frequency and increased in strength as the stimulation is maintained. An increase in frequency to 120 per second or more stops the rhythm and causes the muscle to relax to its contracture level. On decreasing the frequency to its excitatory value, the rhythmicity is resumed, often after a considerable latent period. These results, likewise, are given by the curarized and the noncurarized muscle.

Injection of atropine sulphate into the dorsal lymph sac greatly increases the tendency of the gastrocnemius to contract rhythmically in response to the tetanizing current, and accordingly a much higher frequency is required to stop the rhythm in the atropinized preparation. In one experiment, in which the muscle was both curarized and atropinized, a frequency of 560 per second was hardly sufficient to suppress it. The gastrocnemius of the other leg, which had been atropinized only, exhibited a strong and quite regular rhythm in response to a frequency of 640 per second. Atropine has shown repeatedly this ability to counteract the inhibitory effects of high frequency stimulation.

The results from the apex of the turtle's ventricle have been even more striking. A frequency of interruption of 2.5 per second usually establishes a regular rhythm of contraction. A moderate increase in frequency slows the rhythm and increases the magnitude of the contractions. With a further increase in frequency, the contractions cease and the muscle relaxes almost completely. In this relaxed state, the contractile forces of the muscle are recovered, as indicated by the character of the response obtained when the frequency is lowered again to its excitatory value. Surprisingly low frequencies are inhibitory. Ten interruptions or fewer per second are often sufficient to suppress the rhythm entirely. Atropinization, however, changes the results in a significant manner. Rhythmic contractions are set up by stimulation as before, but extraordinarily high frequencies are required to suppress them—760 interruptions per second often leave the rhythm in progress. It is of interest to note also that atropinization often leads to spontaneous rhythmicity of the apex of the ventricle, which is difficult to check by high frequency stimulation. Pilocarpine, as would be expected, counteracts the effects of atropine. By its application the relations of frequency to effect produced can be made

[1] From the Laboratory of Physiology in the Harvard Medical School.

[2] Veach, H. O., SCIENCE, 1924, LIX, 260.

to revert to those holding for the non-atropinized preparation.

The results obtained from smooth muscle are likewise significant. The siphon muscle of the clam reacts to variation in frequency of stimulation in much the same way as the omohyoid of the turtle, though it relaxes in response to lower frequencies. The frequencies required to cause relaxation of the smooth muscle of the alimentary canal, on the other hand, are extraordinarily high. In one Magnus preparation[3] of the circular coat of the duodenum, taken from a cat anesthetized with urethane, frequencies of 320 and above were required to cause relaxation during stimulation. In a preparation taken from the lower end of the esophagus of a decerebrate cat, and arranged to record the contractions of the longitudinal coat, the myenteric plexus remaining intact, a frequency of 240 per second caused well-maintained, rhythmic contraction. Relaxation took place, however, when the frequency was increased to 400 per second. The latter frequency when applied to the resting preparation, the intensity remaining constant, caused contraction.

These observations tend to establish a definite relation between frequency of stimulation and the response produced in the effector: low frequencies of stimulation are excitatory and high frequencies are inhibitory. The analogy to Wedensky inhibition[4] is close, and we are inclined to account for the results chiefly on the basis of the reduction in magnitude of a propagated disturbance, which travels in the relative refractory phase following its predecessor. This has been shown by Lucas to be true for the sciatic nerve[5] and the sartorius muscle[6] of the frog. We place the seat of reduction of the propagated disturbances to subnormal magnitude in a conducting mechanism of the muscle. The reduced disturbance might be rendered thus subthreshold for the contracting mechanism. Rhythmicity is seen to be explicable on the same basis. Fatigue would lower the threshold of the contracting mechanism and result in relaxation. During relaxation, the contractile forces would be recovered, with a resulting fall in threshold, and the conditions would be established for contraction. The occurrence of contraction, however, would fatigue again the contracting mechanism, and the process might thus be repeated rhythmically. Incidentally, the results indicate that the seat of inhibition for the turtle's heart is within its musculature. They indicate also that the chief cause of the production of Wedensky inhibition may lie in the properties of a conducting mechanism of the muscle fiber.

[3] Magnus, R., *Arch. f. d. ges. Physiol.*, 1904, CII., 349.

[4] Wedensky, N., *Archives d. Physiol.*, 1891, XXIII., 687.

[5] Lucas, K., *Journ. Physiol.*, 1911, XLIII., 46.

[6] Lucas, K., *Journ. Physiol.*, 1909, XXXIX., 331.

A full account of this investigation will appear in the *American Journal of Physiology.*

H. O. VEACH,
J. R. PEREIRA
HARVARD MEDICAL SCHOOL

A HIGH RESISTANCE FOR USE WITH ELECTROMETERS

A QUADRANT electrometer may be used to measure current by two methods: (1) By measuring the rate of deflection when one pair of quadrants is attached to a system of known capacity which is being charged by the current to be measured; (2) by using the electrometer to measure the potential drop across a high resistance through which the current is flowing. The resistance to be used in the latter method should be high, non-polarizable and it is desirable to have it made of such materials that the magnitude of the resistance may be varied to meet the requirements of the experiment. It was suggested by Professor G. N. Lewis that solutions of iodine in non-conducting solvents such as benzene might meet these conditions.

The benzene used in these experiments was washed successively with concentrated sulfuric acid, sodium carbonate solution and distilled water, dried with phosphorous pentoxide and distilled. The iodine used was purified by resubliming the commercial product. The conductivities of the solutions were measured in a glass cell with platinum electrodes which were four centimeters in area and approximately one millimeter apart. The concentrations of the solutions tested varied from 10.62 to 2.69 grams of iodine in 100 cc of solution and the specific resistances ranged from 1.1×10^{11} to 4.8×10^{11} ohms. At the lower concentrations of iodine the conductivity is very nearly proportional to the concentration of the iodine but at higher concentrations the ratio of conductivity to concentration increases slightly. The temperature coefficient is fairly high, the conductivity increasing approximately one per cent. of the value at 20° C. for each degree rise in temperature.

Several resistances have been made using these solutions and have been tested with a Compton electrometer with satisfactory results. The currents which have been measured with this arrangement are of the order of 10^{-15} ampere, but it is evident that by suitable variation of the resistances or of the sensitivity of the electrometer a wide range of currents may be covered. If the resistance is adjusted so that with the maximum deflection observed the potential drop across the resistance is not more than about one tenth of a volt the system rapidly adjusts itself to a change of current. If actual values of the current are desired the system should be calibrated by one of the usual methods.

GERHARD K. ROLLEFSON
UNIVERSITY OF CALIFORNIA